The contribution of agroforestry systems to climate change mitigation – Assessment of C storage in soils in a Mediterranean context

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Introduction

- Agroforestry systems are agroecosystems associating trees with farming practices. They provide a variety ecosystem services whilst maintaining a high agricultural production
- Trees store carbon into their biomass but also produce an important amount of fresh organic matter that could enhance soil organic carbon (SOC) stocks
- Most studies : tropical systems, upper soil layers

Objectives

- Quantify all organic inputs (leaf litter, fine roots, etc.) to soil
- Quantify and spatialize SOC stocks plot to 2 m soil depth
- Identify forms of SOC stored under agroforestry

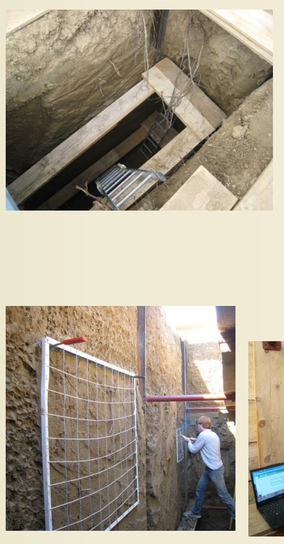
Study site

- Silty and carbonated Fluvisol
- Hybrid walnuts (*Juglans regia* × *nigra*) planted in 1995. Current density: 110 trees ha^{-1}
- Durum wheat (*Triticum turgidum*) sown in the inter rows and in the agricultural control plot

Materials and methods

Organic inputs

- Two pits 150 cm deep + 1 pit 400 cm deep in the agroforestry plot
- Fine root densities: mapping
- Fine root turnover: minirhizotrons at ≠ depth
- Leaf litter: four walnut trees packed with a net
- Natural vegetation in the tree rows: sampling of aboveground and belowground biomass

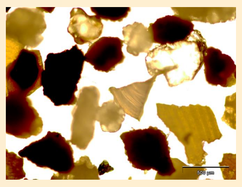


SOC stocks

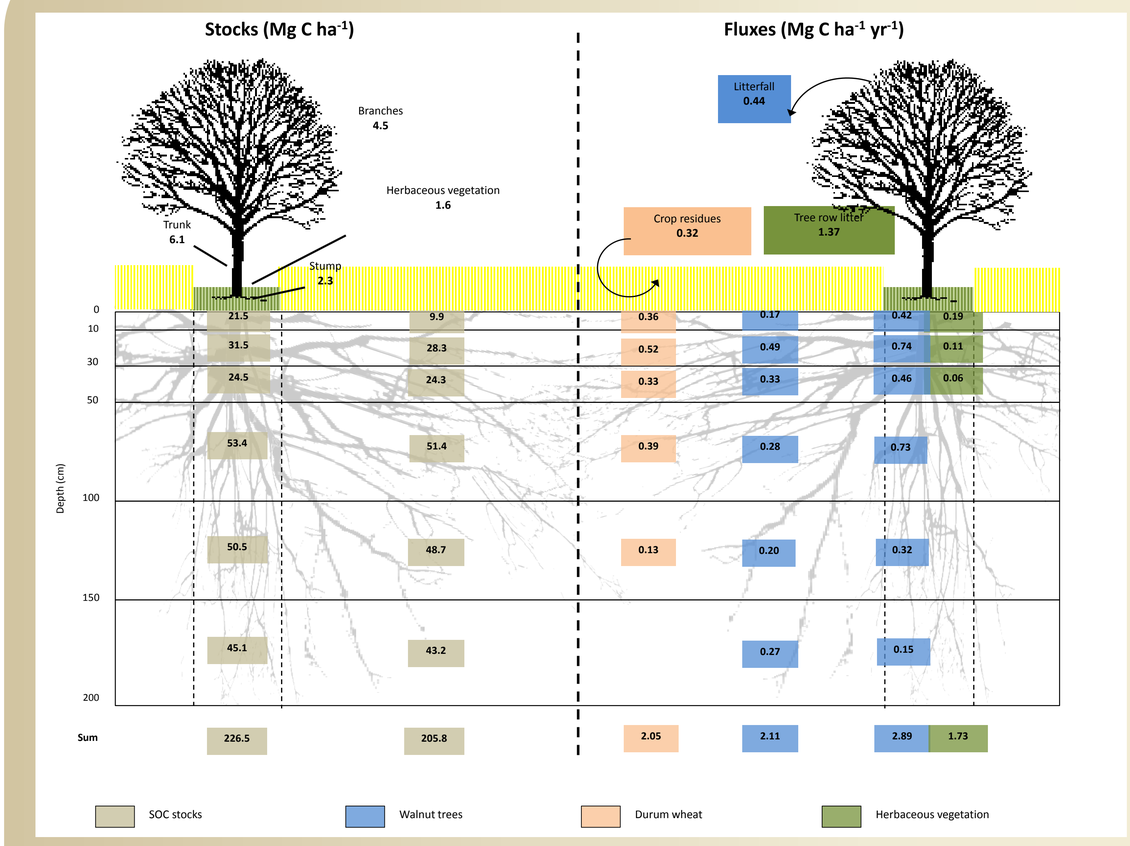
- ≈ 100 soil cores sampled in both plots to 2 m soil depth
- SOC contents estimated using field visible and near infrared spectroscopy
- Bulk densities measured for each soil core
- SOC carbon stocks calculated on an equivalent soil mass basis
- Spatial distribution of SOC stocks studied using geostatistical methods

SOC fractions

- Particle-size fractionation at four depths: 0-10, 10-30, 70-100 & 160-180 cm

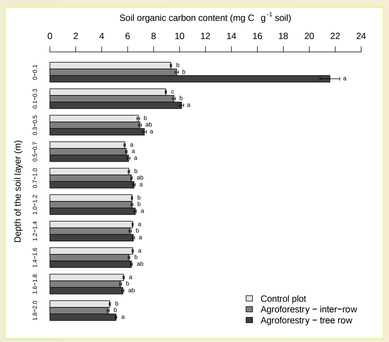


Results

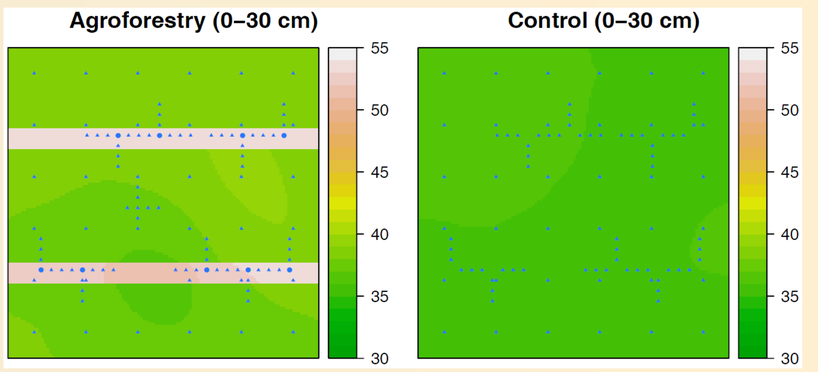


SOC stocks and organic carbon inputs in an agroforestry system.

- Organic C inputs to the soil **increased by 30%** in the agroforestry plot compared to the control plot
- Additional SOC storage rate was **350 ± 88 kg C ha^{-1} yr^{-1}** at 0-100 cm
  - ≈ 75% of additional SOC was located at **0-30 cm**
  - > 50% of additional SOC storage was under **tree rows**
  - Most additional SOC was made of **particulate organic matter** (>50 µm)
- Total carbon (soil + tree aboveground biomass) storage rate was **1.11 ± 0.16 Mg C ha^{-1} yr^{-1}**



Soil organic C contents to 2 m



Map of cumulated SOC stocks (Mg C ha^{-1}).

Conclusion

- Agroforestry systems can efficiently enhance SOC stocks in agricultural lands and contribute to climate change mitigation

References

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